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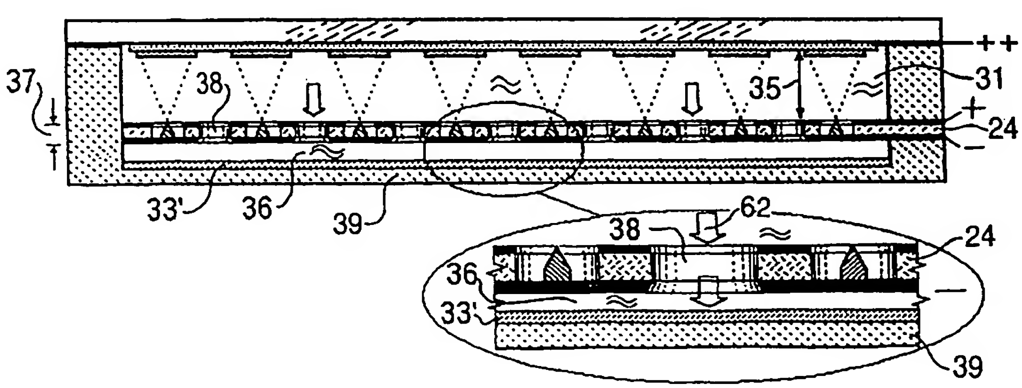

(57) Abstract: Electron emitter structure for field emission display, said disp lay comprising a tabular vacuum chamber confined between a rigid transparent front plate and a substantially flat electron emitting structure comprising a plurality of emitting elements, the residual contaminant gas molecules being removed by transversal pumping through a plurality of pores spread out on said electron emitting structure in order to reach a layer of getter material uniformly distributed over the display area. The emitting elements may be provided by Spindt emitters, sharp or serrated metallic edges or carbon nanotubes. The electron emitting structure comprises an upper and a lower metallic layers plated over the upper and lower surfaces of an insulating plate, the latter consisting of a photo-etchable or plasma-etchable material, such as polyimide or SU8.

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ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY

The present invention is related to flat panel information displays and, more specifically, to FED (Field Emission Display) devices based on electron emission from sharp conducting objects.

It is already known that strong electric fields, in the order of megavolts per centimeter, can be used to provide cold cathode emission from conducting surfaces. It is also well known that when the emitters are shaped as sharp needles or edges, the emission voltage can be reduced to more practical levels, such as a few kilovolts per centimeter.

Such effect can be efficiently used for fashioning electronic devices which operate like electronic valves or, better, as cathode ray tubes, with the advantage of eliminating the cathode heating and saving the power needed when compared to the latter, thus increasing the overall efficiency. Such a device is described in US patent 3,789,471 which shows structures that function as diodes and triodes, where the cathode is shaped like a sharp tip in which the concentration of the electric field produces cold cathode electron emission. The manufacturing process for such electrodes was first described by Spindt in 1968, hence those electrodes are known as Spindt emitters.[1]

As shown in the above mentioned patent document, as well as in US 3665241, the electron source comprises a plurality of Spindt emitters, conical or pyramidal, placed over a conducting substrate, with the addition of an accelerating grid-like structure consisting of a conducting foil electrically insulated from the substrate, provided with holes having their centers coinciding with the tips of the Spindt emitters.

The drawings in Fig. 1 show several electron

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[1] Spindt, C. "A Thin-Film Field Emission Cathode", Journal of Applied Physics, Vol. 39, No. 7, June 1968

emitting structures: the perspective view in Fig. 1-a and the corresponding cross-section view in Fig. 1-b show an electron emitter structure consisting of pyramidal Spindt emitters 12 where the holes 15 of the grid foil 14 are square shaped. Said pyramidal emitters are placed over a conducting substrate 11, insulated from the grid sheet by an insulating layer 13. The drawings in figures 1-c and 1-d show cone-shaped Spindt emitters 12', the holes 15' in the grid 14' being circular in this case. In both embodiments shown in Fig. 1, the Spindt emitter tips are substantially on the same plane as the upper face of the grid foil 14 or 14'. The drawings also show that in the embodiments of figures 1-a and 1-b, the conducting substrate is self-supported, while in the one shown in figures 1-c and 1-d, the conducting substrate rests upon an insulating base 10.

As described in the aforementioned documents, electrons are emitted when a negative voltage is applied to the substrate 11, the grid foil voltage being positive. The amount of emitted electrons can be controlled by varying the voltage applied to the grid 14 or 14'. The addition of a separating insulator plate 17 and an anode 16, as shown in Fig. 1-e, yields a triode-like structure. A positive voltage, higher than the grid voltage, is applied to this anode. The assembled parts form a gas-tight chamber 18 which is evacuated.

This basic structure can be used for fashioning lighted panels, in which a transparent anode is coated with a layer of luminescent material – "phosphor" – which emits light when struck by electrons, similarly to what happens in a CRT face.

A problem which occurs with devices of this kind lies in the contamination of the vacuum by gas molecules which are gradually released from the material surfaces. Experimental data show that such devices only operate reliably when the gas pressure inside the evacuated chamber is equal or less than 10^{-6} torr. With higher pressures, the gas molecules may become ionized; these ions are attracted by- and strike the electrically biased surfaces, impairing

the emitting structures. Moreover, even when this ionization is absent, gas molecules are adsorbed by the exposed surfaces, modifying the work function of the emitter material and degrading the phosphor layer.

The removal of the molecules from the region in which the electrons travel is achieved by placing inside the evacuated chamber a getter which binds the contaminant gas molecules.

Fig. 2 shows a light emitting display built according to the known technique. Said display comprises a cathode structure composed of a conducting backplate 21 that can be self-suporting or bonded to a rigid insulating slab 20, this backplate being provided with a plurality of Spindt emitters 22 centered at the bottom of through-holes 23 provided in an insulating panel 24 attached to the internal surface of said conducting backplate, the outside surface of said insultaing panel being overlaid with a control grid 25 consisting of a conducting foil provided with holes 26 concentric with said through-holes 23 and said emitters 22, the assemblage of the above mentioned elements forming the electron emitting structure or the cathode structure. The display also comprises a rigid transparent front plate 27, usually made of glass, having its internal surface coated with a transparent conducting film 28 (anode); the inside surface of this anode is overlaid with phosphor 29, either as a continuous layer or as a plurality of discrete spots which constitute the picture elements – pixels.

The display shown in Fig. 2 differs from the assembly of Fig. 1-e by the fact that the vacuum chamber comprises the full extension 32 of the device, to allow the displacement, by gaseous diffusion, of the contaminant molecules, from any place in the vacuum chamber to the getter 33 which is placed on a trough 34 provided along one side of the display. This displacement of the gas molecules along the length of the display is called "longitudinal pumping". The spacing elements between the front plate and the

cathode structure in the display of Fig. 2 have been omitted in this drawing for clearness sake.

The pixel definition, specially in the case of colored displays, hinges on the production of sharply defined electron beams, because the defocussing of the beam will result in that a part of the electrons will impinge on phosphor spots of different colors than intended. One of the main causes of this defocussing is the distance travelled by the electrons between the tip of the Spindt emitter and the picture element, i.e., the phosphor spot. In displays built according to known techniques, this distance 35 is about one millimeter, resulting in an unacceptable image quality unless complex and expensive additional structures – not shown in the figure – are used to control the scattering of the electron beams. A more straightforward way of lessening said scattering would be to reduce the distance between the emitter structure and the front plate.

However, this reduction will give rise to a pressure gradient along the display's length, impairing the vacuum in the regions of the display farther from the getter. This effect depends on the relation between the display size 32, typically of the order of 10, 20 or more centimeters, and the free gap 35 between the cathode structure and the front plate. An adequate longitudinal pumping will result only when said gap is equal or greater than 1 millimeter. However, as mentioned before, such large distances require the addition of complex and expensive structures, such as the one described in US 6,013,974.

The approximation between the front plate and the cathode structure constitutes a more straightforward solution for the defocussing problem, due to the fact that the reduction of the path traversed by the electrons before impinging in the front plate will reduce the spot illuminated by the electron beam, which will impinge upon one picture element only, doing away with the need for additional focussing means. However, this nearness diminishes the

vaccum conductance, hindering the displacement of contaminant gas molecules along the display length, resulting in a residual pressure gradient. This lack of uniformity in the vacuum quality will bring about the deterioration of the emitter elements as well as of the phosphor, which will be more intense on the central part of the display, resulting in a lack of picture uniformity.

In view of the preceding, therefore, it is the aim of the present invention to produce an uniform vacuum, giving rise to a uniform image quality in the full extension of the display, without recourse to complex and expensive focussing structures.

The above mentioned aim is achieved by the invention by providing a substantially uniform distribution of the getter along the full extension of the display, the path of the gas molecules toward the getter being substantially perpendicular to the electron emitter structure, said path comprising a plurality of pores uniformly distributed along said structure.

According to another feature of the invention, the depth between the pore front and back openings is smaller than their transverse dimension.

According to another feature of the invention, the getter is placed in a chamber occupying the full extension of the display, said chamber being placed between the rear face of the electron emitting structure and the back closing plate of the display.

According to yet another feature of the invention, the getter is plated over the inside surface of said closing plate.

According to a further feature of the invention, the pore edges are metal plated and function as electron emitters.

The foregoing characteristics, as well as other aspects and advantages of the invention will become more evident from the description of the following embodiments, shown as examples and not in a limiting sense, as depicted in the attached drawings where similar reference numbers identify similar parts.

Fig. 1 shows the underlying principles of known Spindt emitters.

Fig. 2 shows a FED display built according to known techniques.

Figure 3 is a section view of a FED display built according to the invention.

Fig. 4 shows a perspective view of the electron emitting structure according to the invention.

Fig. 5 shows a cathode structure of a FED display in which the electrons are emitted by the pore edges.

Fig. 6 shows an alternative arrangement of the electron emitting structure depicted in the previous figure, in which the pore edges are coated with a DLC layer.

Fig. 7 shows a preferred embodiment for the pore in the shape of a polygon.

Fig. 8 shows a further embodiment of the electron emitting structure.

Fig. 9 shows an alternative distribution of emitter elements and pores.

Fig. 10 shows further versions of the electron emitting structures in which the electrons are emitted by carbon nanotubes.

The display built according to the invention, depicted in Fig. 3-a, comprises a front plate similar to the one in the known display shown in Fig. 2, however it differs from the latter as regards the electron emitting structure 37, as well as the back chamber 36 that spans the full extension of the display. This chamber is positioned between the back of said structure and the inside face of the closing plate 20'. Said structure consists of an insulating plate 24 overlaid with metallic conducting layers in both upper and lower surfaces. The material of said plate is polymer that can be engraved by photo-etching or plasma etching process, such as polyimide or

SU8.

As shown in the detailed view of Fig. 3-b, the insulating plate is provided with a plurality of through holes or pores 38, allowing the contaminating gas molecules to pass freely from the vacuum chamber 31 to the getter layer 33' that coats the inside surface of the back closing plate 39. This molecular diffusion proceeds in a direction perpendicular to the plane of the display, as shown by the arrows 62, being called "transverse pumping". It should be noted that, in the present case, the path traversed by the gas molecules to reach the getter is much shorter than in the case of longitudinal pumping, the vacuum conductance being, therefore, correspondingly larger. Moreover, with the arrangement shown in Fig. 3 the vacuum conductance is not affected by the gap 35 between the cathode structure 37 and the front plate; therefore, this distance can be reduced as required to avoid defocussing of the electron beams due to scattering.

Fig. 4 shows a perspective view of the display built according to the invention, with the front plate removed. As depicted, the pores 38 are interspersed with the Spindt emitters 22, the getter layer 33' being visible through said pores.

Notwithstanding the fact that figures 3 and 4 show pores and Spindt emitters in roughly the same quantities, this relation can be changed as needed by circumstances. Although the drawings depict said elements as being about the same size, in practical devices the emitters are substantially smaller than the pores. Typical Spindt emitters measure about 1 micrometer, while the pore diameters are on the order of tens of micrometers. Therefore, cathode structures such as shown in Fig. 9 can be fashioned, in which each pore 38 corresponds to a group 22' comprising several Spindt emitters, without overstepping the bounds of the invention.

In a second embodiment of the inventive concept, depicted in Fig. 5, the electrons are not emitted by Spindt

elements but by the sharp edges 41 of the metallic plating that, besides covering the lower surface of insulating plate 45, extends in the upper direction covering the pore walls 43 and reaching the upper surface of said insulating plate. This embodiment has the favorable feature of increasing the size of the region of high electric field concentration, i.e., the region from which the electrons are emitted. Indeed, said emission can take place along the full edge of the pore wall plating, while in a Spindt device the electrons issue only from the tip of the cone or pyramid. To insure that emission occurs along the whole perimeter of the pore edge, said edge can be serrated, so that a large number of sharp tips are available for electron emission.

Figure 6 shows an arrangement similar to the one of the preceding drawing, however in this case the emitting edge 41 is overlaid with a membrane 44 of DLC (diamond-like carbon). This layer, which in practice ranges between 5 and 50 nanometers thick, reduces the work function at the metal surface, facilitating the electron emission from said pore edges.

The pore shape is not restricted to a circle, as shown in Fig. 4. Actually the pores can be shaped as ovals, polygons or slits, provided the distance between the side walls is greater than the depth measured between the upper and lower openings. A specially effective shape is that of a polygon having alternately outward and inward angles, such as, for example, in the polygons that satisfy Jordan`s theorem.

The drawings in Fig. 7 show a triode type electron emitting structure, in which each emitting pore 51 has the shape of a 6-point star. As depicted, the pore lies substantially at the center of a circular depression 52 in the insulating plate 57. In case of irregular or asymetric pores, the depression will be proportionately shaped. As shown in the detailed view of Fig. 7-b, said depression 52 lies between the edge of the metal-clad upper surface 56 of the insulating plate 57 and the electron emitting elements, which happen to be the star

points 53. As is the case with the structures shown in figures 5 and 6, the conducting foil 54 which covers the insulating plate lower face extends upwards into the pore 51 side walls and reaches the bottom plane of said depression 52. Said foil may consist of a metal such as copper, molybdenium, tungsten, etc.. The electron emission can be facilitated by plating the emitter points 54 with DLC or with a low-work-function material, such as a boron compound.

As shown in Fig. 7-b, the lower conducting foil 54 is connected to the (–) pole of a power supply. The upper foil 56, which functions as the control grid, is connected to the (+) pole of the same power supply, the emitting elements being negatively biased relative to the grid. The brightness of the light emitted by the phosphor layer 58 depends on the electron kinetic energy, which is a function of the accelerating voltage applied to the transparent conducting anode 59 overlying the internal face of the front plate 57. This accelerating voltage (++) is equal or greater than 3 kV, which is much higher than the control grid voltage, typically 100 volts.

In a triode arrangement such as the one shown in Fig. 7, the voltage between the electron emitting element and the control grid may be varied with the purpose of controlling the electron beam intensity and thus the brightness of the illuminated spot. This control is made possible by the fact that the distance between the emitter tip 53 and the edge of the grid layer 56 is much smaller than the distance between the electron emitting structure and the transparent conducting layer 59 – the anode – which overlays the front plate 57. Typical values are 2 micrometers for the first distance and 300 micrometers for the second, wherefore the electrons emitted by the tips 53 travel along a parabola-like path 55, starting toward the grid and gradually veering toward the anode due to its stronger electric field.

In all the embodiments of the invention, the electron emission is stabilised by placing a resistance in series whith

each electron emitting element. Said resistances are omitted in the drawings for clarity's sake.

In another embodiment of the invention, the back chamber 36 is eliminated by placing the back closing plate 20' flush against the rear face of the electron emitting structure, such as depicted in Fig. 8. In this case, the pore will be shaped as a shallow well, in which the bottom opening is closed by the rear continouous metallic layer 21' sandwiched between the insulating plate 24 and said back closing plate 20'. Thus, as depicted in Fig. 8, the getter 33" will overlie only the exposed portion of the metallic layer that closes the bottom opening of pore 38'. It should be stressed that, while the embodiment shown in Fig. 8 shows Spindt emitters, the same basic idea is suitable for embodiments employing pores with emitting edges such as – but not limited to – the ones depicted in figures 5, 6 and 7.

In a second set of alternative embodiments of the invention, the Spindt emitters are substituted by clumps of carbon nanotubes, which also emit electrons at room temperature. The embodiments employing carbon nanotubes are shown in figures 10-a, 10-b and 10-c. The first two of these are equivalent to the electron emitting structures of figures 3 and 8, while the embodiment depicted in Fig. 10-c differs from the previous ones by having a self-supporting insulating backing plate 64 under the rear continuous metallic layer 21' over which are placed the carbon nanotube disk-like clumps 61. This latter structure can also be used with Spindt emitters. In all cases, the pores 38' are interspersed with the electron emitting elements, to provide a path that allow the contaminating gas molecules to reach the getter layer 33'.

Said carbon nanotubes can also be used in conjunction with edge emitting pores, in which case the nanotubes will be applied in a layer over the metallic edge bordering said pores.

As mentioned previously, each electron emitting element has a ballast resistance connected in series for emission

stabilisation purposes, said electron emitting element being either a Spindt emitter, the pore metallic edge or a clump of carbon nanotubes. When emitting pores are used, said resistance can be provided by reducing the cross-section of the metallic plating on the pore walls.

Two kinds of biasing setups can be used in FED display devices having electron emitting structures that use carbon nanotubes, such as the ones shown in the drawings of Fig.10. In the first, the carbon nanotubes are negatively biased, the grid layer 25 has a small positive bias and the anode is strongly positive. In the second biasing setup, the nanotubes are positive, the grid is negative and the anode is strongly positive.

Additional advantages of the present invention will readily occur to those skilled in the art while keeping within the conceptual bounds of the invention. For instance, although the front plate is depicted as being coated on the inside with the transparent anode and the phosphor overlaying said anode, the placement of these layers can be reversed, as is the usual practice in TV picture tubes. In such case, the phosphor layer is applied directly over the inside surface of the front plate and the anode consists of a thin reflecting aluminum film placed over the phosphor layer. This setup increases the image brightness and contrast due to the reflection of the light emitted in the backward direction by said aluminum layer.

Therefore, in consideration of the preceding, the spirit and scope of the invention are limited and defined by the appended claims.

CLAIMS

1. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY, said display comprising a tabular vacuum chamber (31) confined between a rigid front plate (27) coated on the inside with a transparent anode (28) and a luminescent material (29) and a substantially flat electron emitting structure (37) comprising a plurality of emitting elements, the residual contaminant gas molecules being absorbed by a getter material (33, 33'), **characterised** by the fact that said getter material (33') is uniformly distributed over a region substantially equivalent to the display area, and by the fact that the paths of said molecules between said vacuum chamber (31) and said getter material go through a plurality of pores (38) spread out over said electron emitting structure (37), said paths being substantially perpendicular to the main plane of the display.

2. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 1, **characterised** by the fact that said electron emitting structure comprises an insulating plate (24) overlaid with metallic conducting layers (21, 25) in both upper and lower surfaces, the material of said plate being a polymer that can be engraved by photo-etching or plasma etching process. such as polyimide or SU8.

3. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 2, **characterised** by the fact that said polymer consists of polyimide.

4. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 2, **characterised** by the fact that said polymer consists of SU8.

5. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 1, **characterised** by the fact that the depth (37) between the entrance and exit openings of said pores (38, 38') is smaller than the distance between the pore side

walls.

6. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 1, **characterised** by the fact that said display comprises a back chamber (36) spanning the full extension of the display, confined between the back face of the electron emitting plate structure (37) and a back closing plate (20'), the pores (38) provided in said emitting plate structure functioning as passage means for the contaminant gas molecules between the vacuum chamber (34) and said back chamber(36).

7. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claims 1 or 6, **characterised** by the fact that said getter material (33') is placed within said back chamber (36).

8. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claims 1, 6 or 7, **characterised** by the fact that said getter material (33') forms a layer that covers the inside surface of said back closing plate (20').

9. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 1, **characterised** by the fact that said electron emitting elements are provided by Spindt emitters (22, 22').

10. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 1, **characterised** by the fact that said electron emitting elements are provided by clumps of carbon nanotubes (61).

11. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 9, **characterised** by the fact that said electron emitting elements employing Spindt emitters are interspersed with said pores (38).

12. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 10, **characterised** by the

fact that said electron emitting elements employing carbon nanotubes are interspersed with said pores (38).

13. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 2, **characterised** by the fact that the metallic plating (42) that covers the lower surface of the insulating plate (45) that functions as the base of said electron emitting structure, extends inside the pore walls and reach the upper surface of said insulating plate forming a sharp edge (41).

14. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 13, **characterised** by the fact that said sharp metallic edge (41) is serrated.

15. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claims 1, 2, 13 or 14, **characterised** by the fact that the pores have their cross-section in the shape of a polygon that satisfies Jordan's theorem.

16. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 15, **characterised** by the fact that the pores have their cross-sections formed as star-shaped polygons (51).

17. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claims 13, 14, 15 or 16, **characterised** by the fact that said sharp metallic edges (41, 54) are overlaid with DLC (diamond-like carbon).

18. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claims 13, 14, 15 or 16, **characterised** by the fact that said sharp metallic edges (41, 54) are overlaid with a low-work-function material.

19. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claim 18, **characterised** by the fact that said low-work-function material is a boron compound.

20. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claims 13, 14, 15 or 16,

charact ris d by the fact that said sharp metallic edges (41, 54) are overlaid with carbon nanotubes.

21. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in claims 1 or 2, **characterised** by the fact that the back closing plate (20") is juxtaposed against the rear face of the electron emitting structure, the back openings of the pores (38') being closed by the rear continuous metallic layer 21' that is a component of said electron emitting structure, the portions of said metallic layer enclosed by the perimeter of said pores being coated with getter material (33").

22. ELECTRON EMITTER STRUCTURE FOR FIELD EMISSION DISPLAY as claimed in any of the preceding claims, **characterised** by the fact that a resistance is provided in series with each electron emitting element.

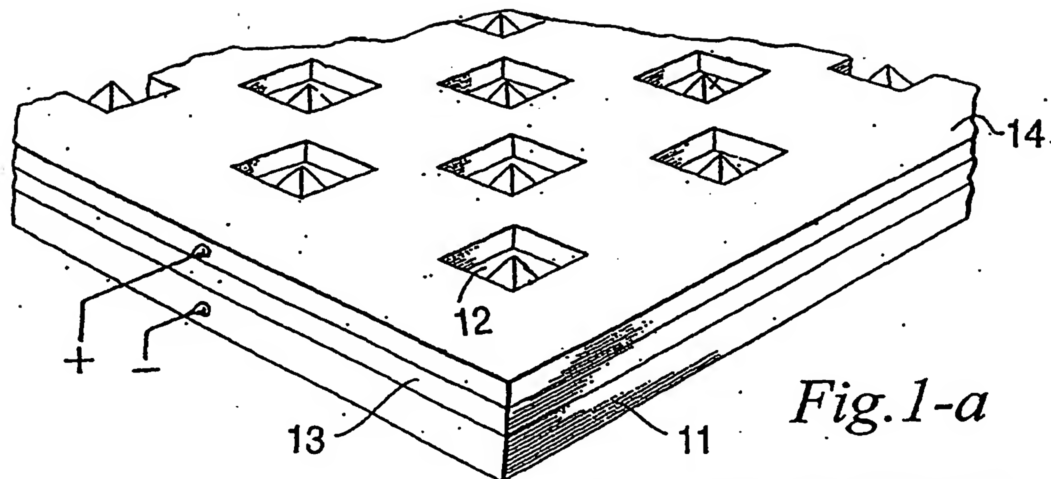

Fig.1-a

(PREVIOUS TECHNIQUE)

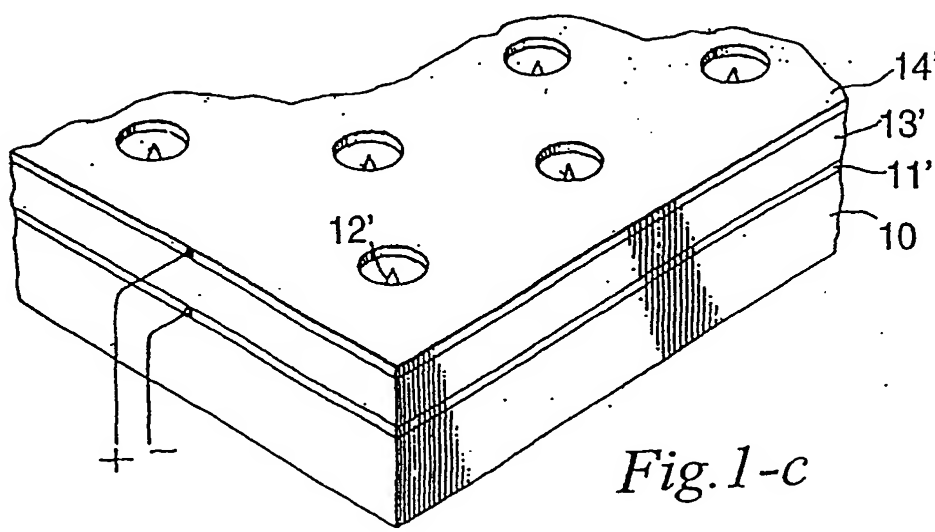

Fig.1-c

(PREVIOUS TECHNIQUE)

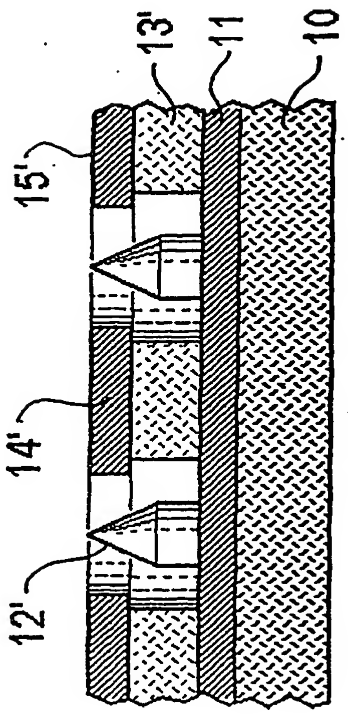

Fig. 1-d
(PREVIOUS TECHNIQUE)

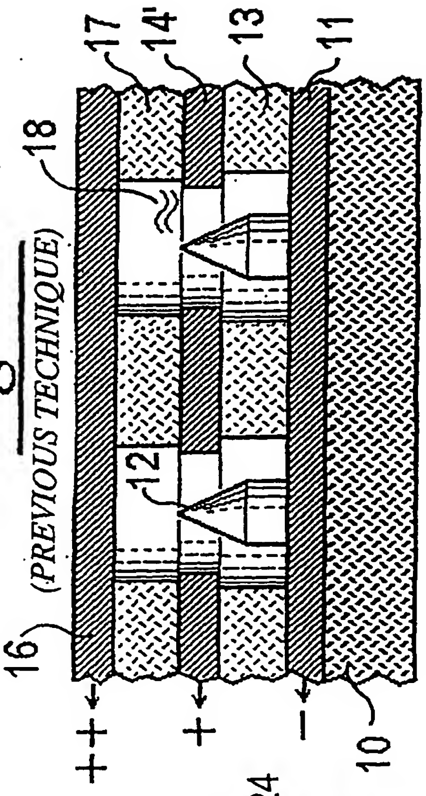

Fig. 1-e
(PREVIOUS TECHNIQUE)

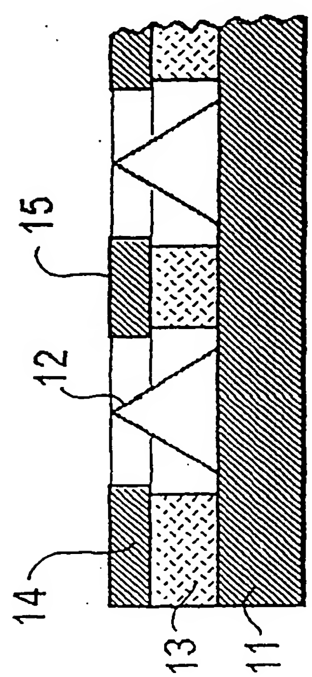

Fig. 1-b
(PREVIOUS TECHNIQUE)

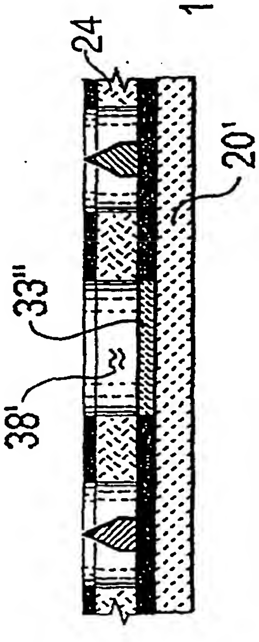

Fig. 8

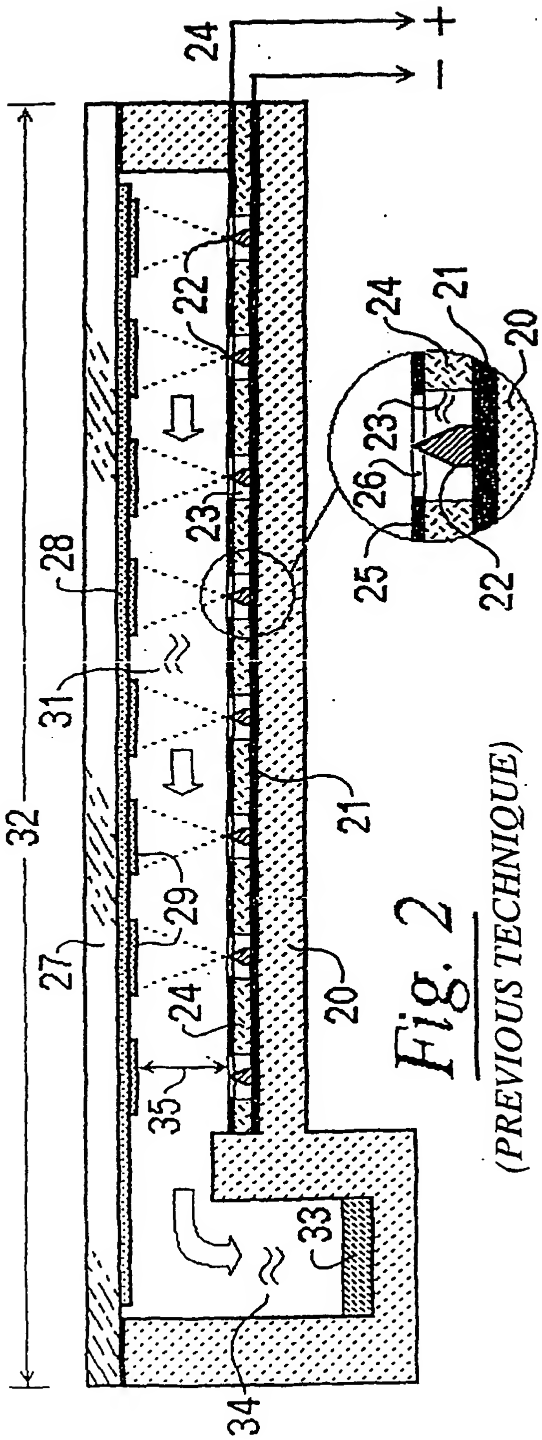

Fig. 2
(PREVIOUS TECHNIQUE)

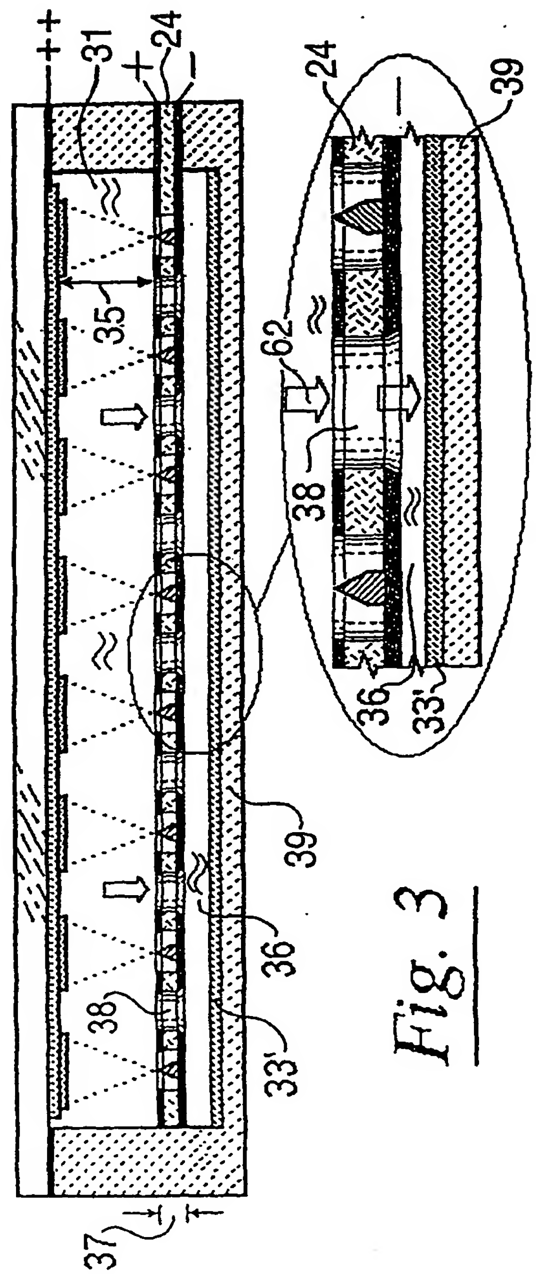

Fig. 3

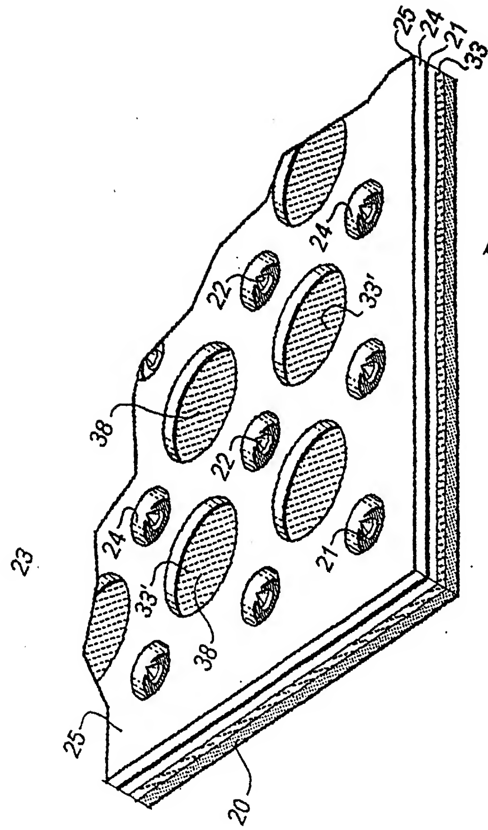

Fig.4

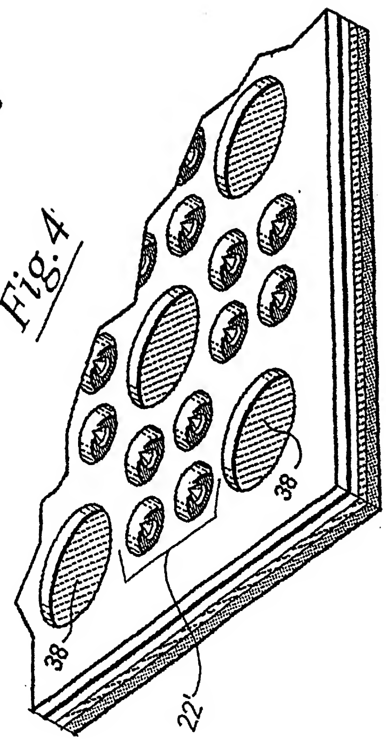

Fig.9

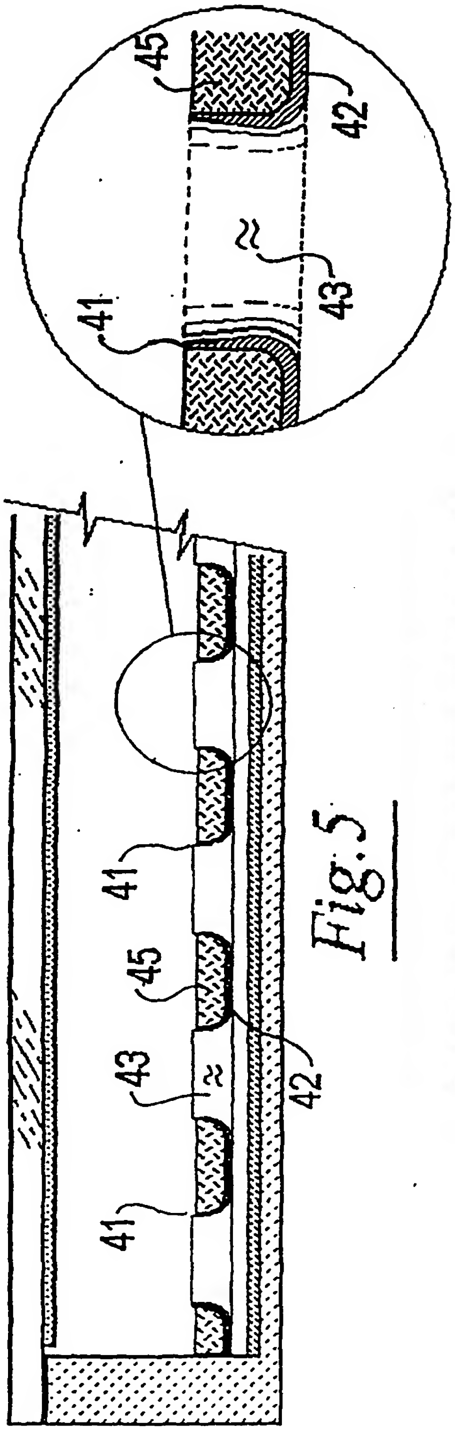

Fig.5

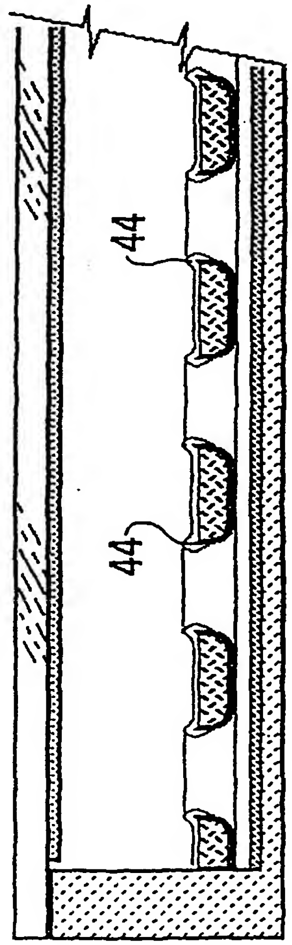

Fig.6

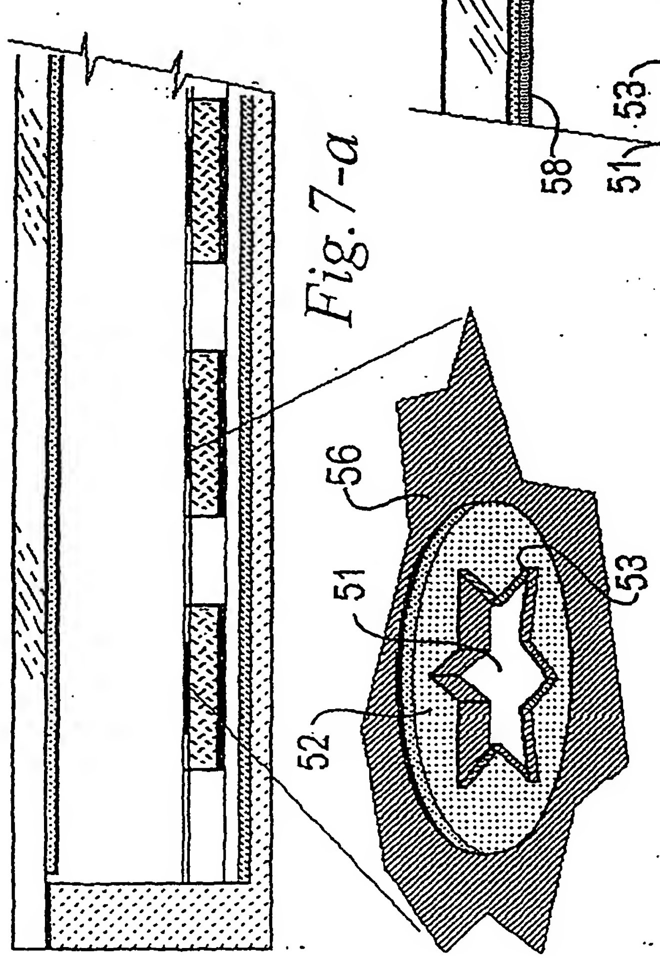

Fig. 7-a

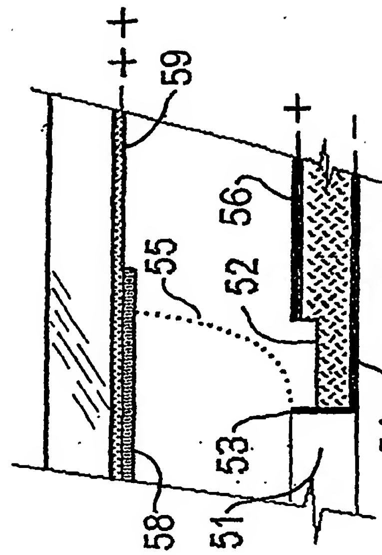

Fig. 7-b

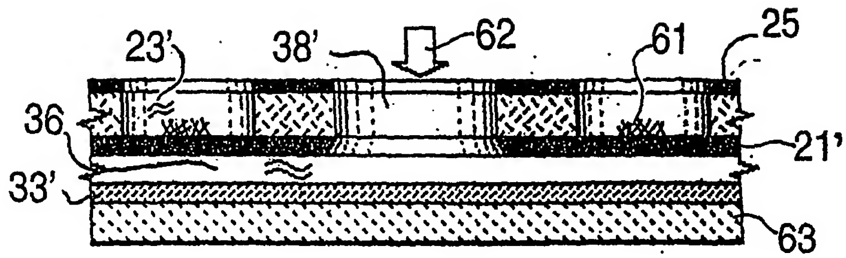

Fig.10-a

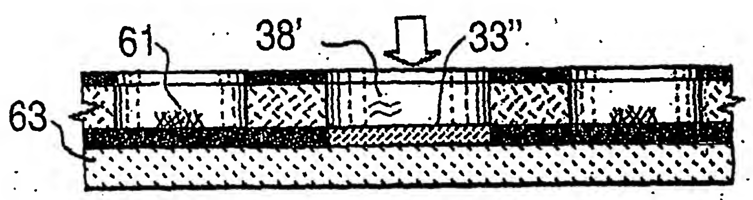

Fig.10-b

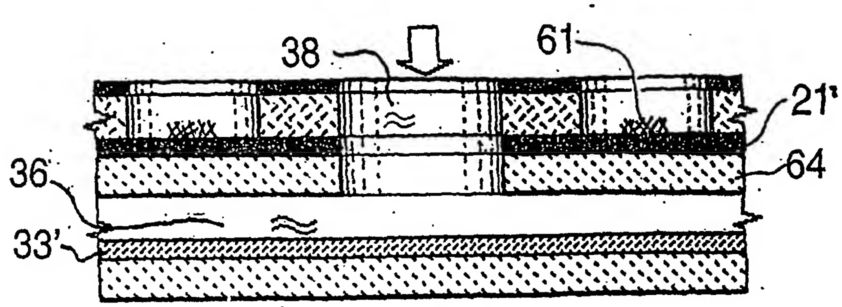

Fig.10-c

INTERNATIONAL SEARCH REPORT

International application No.
PCT/BR 01/00046

CLASSIFICATION OF SUBJECT MATTER

IPC[7]: H01J 7/18, 1/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC[7]: H01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5763998 A (Colombo) 9 June 1998 (09.06.98) *col. 5, line 44 - col. 6., line 40.*	1-9,11,21,22
Y	JP 10 149760 A (Toshiba) 2 June 1998 (02.06.98) & US 6097138 A (Nakamoto) 01.08.2000 *fig. 16 and description.*	10,12,20
Y	EP 0434001 A2 (Matsushita) 26 June 1991 (26.06.91) *fig. 16 and 21 with description.*	13-19

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
16 August 2001 (16.08.2001)	30 August 2001 (30.08.2001)

Name and mailing adress of the ISA/AT	Authorized officer
Austrian Patent Office Kohlmarkt 8-10; A-1014 Vienna Facsimile No. 1/53424/535	SCHLECHTER Telephone No. 1/53424/448

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/BR 01/00046

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